ATTACHMENT 1

APPENDIXES

SOVIET ACQUISITIONS OF WESTERN TECHNOLOGY

AND PROJECTED SOVIET TECHNOLOGICAL NEEDS

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SOVIET ACQUISITIONS OF WESTERN TECHNOLOGY AND PROJECTED SOVIET TECHNOLOGICAL NEEDS

Appendix I contains tables of technology and equipment acquired by the Soviets, and where the end-use of the acquisition is known or the likely benefit to the Soviets appears clear such information has been included. In many instances, however, the technology acquired can find application in various Soviet weapons programs. This is probably most true in the electronics and computer areas. In these cases the candidate applications that have been estimated are by no means complete. Finally, the reader should note that each entry frequently represents several transactions or transfers that are related to the same technology, and that probably contributed to a given Soviet program. Appendix II contains brief descriptions of Technological areas where the Soviets are deficient and will be thus likely to attempt to acquire Western technology.

APPENDIX I

Soviet Acquisitions of Western Technology

STRATEGIC SYSTEMS

The Soviets' strategic weapons program has benefited substantially from the acquisition of Western technology, including those shown in Table I. Their ballistic missile systems in particular have, over the past decade, demonstrated qualitative improvements that probably would not have been achieved without Western acquisitions. The most striking example of this is the marked improvement in accuracy of the latest generation of Soviet ICBMs--an improvement which, given the level of relevant Soviet technologies a decade ago, appears almost certainly to have been speeded by the acquisition of Western technology.

TABLE I: STRATEGIC RELATED EQUIPMENT AND TECHNOLOGY ACQUIRED BY THE SOVIET BLOC

EQUIPMENT OR TECHNOLOGY	COMMENTS
Missile Test Range Instrumentation System and/or Its Documentation	Instrumentation of this type collects data critical to postflight analysis. As such, it may well have expedited Soviet weapons development programs, particularly those for ballistic missiles.
Minuteman ICBM Silo Technical Data	There are striking similarities between the Minuteman silo and the Soviet SS-13 silo. Acquisition could have expedited deployment of this, the first solid-propellant Soviet ICBM.
Machines for the Manufacture of Precision Instrument Bearings	The precision of ballistic missile guidance components and, hence, the accuracy of these systems is largely dependent on the quality of their bearings. Much of the Soviet equipment used in the manufacture of these bearings was obtained from the West.
Precision Cinetheodolites	The Soviet acquisition of these instruments could measurably improve the optical tracking capability at several of their ballistic missile test ranges, and thus expedite flight test programs.

NAVAL SYSTEMS

The Soviets' acquisition effort in the naval area reflects well the two major factors that motivate their requirements: the acquisition of technology not readily available to them--yet critical to their programs-- and the acquisition of equipment which, while producible in the Soviet Union, allows them to divert resources to more pressing naval programs. Table II shows that Soviets appear to have concentrated their acquisitions in areas related to aircraft carriers, deep sea diving capabilities, sensor systems for antisubmarine warfare and navigation, and ship maintenance facilities.

TABLE II: NAVAL EQUIPMENT AND TECHNOLOGY ACQUIRED BY THE SOVIET BLOC

EQUIPMENT OR TECHNOLOGY	COMMENTS
Very Large Floating Drydocks	The Soviets purchased two of these from Western suppliers. These are the only drydocks that the Soviets have available in their major fleet areas for servicing their largest combatants--including the new carrier for high-performance aircraft that is under development. Additionally, these drydocks could not have been produced at Soviet shipyards without facility modifications that would require major capital expenditures and cause interruptions in present weapon programs.
Aircraft Carrier Catapult Equipment and/or Documentation	We suspect that the Soviets may have acquired this technology which, though relatively common in the West, is outside the Soviet experience. Directly applicable to their new aircraft carrier development program.
Underwater Low-Light-Level Television Camera and Systems for Remote Operation	Provides the Soviets with a capability for close-up observation of Western equipment and for maintenance and repair of their own systems.
Machine Tools for Cutting Large Gears	These gear-cutting machines are required to produce the very large gears used in ship propulsion systems.
Titanium Furnace	Used in producing titanium plate of a size applicable to their submarine program.

Oceanographic Ships & Equipment	The surveys these ships conduct support activity for both their strategic and tactical naval effort. Ocean physics and chemistry studies provide data necessary for antisubmarine warfare sensors.
Navigation Satellite Receivers	Useful for any naval application where precision positioning is desired.

AIRCRAFT SYSTEMS

While much of the Soviet acquisition in the aircraft area appears directed toward the development of countermeasures against Western systems, the Soviets appear to target data on Western aircraft primarily to acquire the technology. Furthermore, while they have acquired a large amount of hardware and data from planes downed or captured in Vietnam and elsewhere, they continue to attempt to acquire the most advanced technologies through both open and illegal transactions with the West. Assimilation of Western technology has been of great benefit to both their commercial and military aircraft development programs -- to the extent that aircraft from certain Soviet design bureaus are to a significant degree copies of aircraft subsystems of Western design.

TACTICAL SYSTEMS

Although Soviets have a strong indigenous technology base that could support the development of much of their tactical weaponry, this does not prevent them from maintaining an ambitious program for acquiring and benefiting Western technology in this area. In some cases, their acquisitions probably satisfy a deficiency in Soviet technology. Smart weapons technology and electro-optical technology are probably examples of this. Signal and

information-processing technology, particularly for Soviet air defense systems, is another. Probably more often, however, technology is exploited more to speed up a developmental program, or, by "product testing" of sorts, to improve upon original Western designs in an expeditious manner.

MICROELECTRONICS TECHNOLOGY

Western equipment and technology have played a very important, if not crucial, role in the advancement of Soviet microelectronic production capabilities. This advancement comes as a result of the illegal acquisition of tens of hundreds of pieces of Western equipment.

Table III contains those production-related illegal acquisitions that have significantly benefited the Soviets. These acquisitions have been grouped into areas related to the four steps required to produce a microchip: wafer preparation, circuit-mask making, device fabrication, and assembly and testing. Table III shows that the Soviets acquired a massive amount of production equipment (with the mask-making technology being extremely important). By combining this acquired Western equipment and technological know-how, the Soviets could satisfy 100 percent of their military microelectronic needs or 50 percent of all their microelectronic needs.

TABLE III: MICROELECTRONIC EQUIPMENT AND TECHNOLOGY ACQUIRED BY THE SOVIET BL

EQUIPMENT OR TECHNOLOGY	COMMENTS
Process Technology for Microelectronic Wafer Preparation	The Soviets have acquired hundreds of specific pieces of equipment related to wafer preparation, including epitaxial growth furnaces, crystal pullers, rinsers/dryers, slicers, and lapping and polishing units.
Process Technology for Producing Circuit Masks	Many acquisitions in this area include computer-aided design software, pattern generators and compilers, digital plotters, photorepeaters, contact printers, mask comparators, electron-beam generators, and

	ion milling equipment.
Equipment for Device Fabrication	Many hundreds of acquisitions in this area have provided the Soviets with mask aligners, diffusion furnaces, ion implanters, coaters, etchers, and photochemical process lines.
Assembly and Test Equipment	Hundreds of items of Western equipment, including scribers, bonders, probe testers, and final test equipment have been acquired by the Soviets.

COMPUTER TECHNOLOGY

As in the case of microelectronics, acquisition of computer technology finds wide application within the Soviet Union. The acquisition of company proprietary technical documentation, augmented by actual hardware of advanced large Western general purpose computers has been instrumental in advancing the development of the idigenous Soviet Ryad-series general purpose computer. In addition to the advantage gained by the exploitation of computer technologies, the acquired computer hardware also is being used for military related applications.

TABLE IV: COMPUTER EQUIPMENT AND TECHNOLOGY ACQUIRED BY THE SOVIET BLOC

EQUIPMENT OR TECHNOLOGY	COMMENTS
Design concepts of the US IBM 360 and 370 series of computers	The Soviets Ryad series of computers is patterned after the IBM 360 and 370 series. This Soviet series has had a wide variety of applications in the civilian and military industires. The adaptations of the US computer have eliminated many of the high risks in undertaking the development and production of a new series of general purpose computers and saved the Soviets considerable time and man-power.
US Microporcessors and advanced microdevices	Can be used as the processors for a variety of special purpose computers. US designs were copied by the Soviets for production in the USSR.

Software, probably for operating systems	Could assist in the general software design of Soviet general purpose computers.
Numerous Western general purpose minicomputers, and microcomputer acquisitions	In general, these acquisitions could compensate for the inability of the Bloc computer industry to satisfy its consumer requirements. These units could therefore either be used for military applications or could free indigenous equipment for these applications.
IRIS-80 Computer System	This a powerful system. The computer is useful for antisubmarine warfare detection and classification problems.

APPENDIX II

Projected Soviet Technological Needs and Acquisition Targets Through the 1980s

PROJECTED SOVIET TECHNOLOGICAL NEEDS AND ACQUISITION TARGETS THROUGH THE 1980s

Given the dynamic nature of their collection program, it is expected that the Soviets will continue their attempts to acquire a broad range of Western technologies. Certain areas, however, represent priority collection targets for them; these areas are critical to the Soviets' enhancement of their weapons capability, in which they have marked deficiencies.

FUTURE SOVIET STRATEGIC TECHNOLOGY NEEDS

Over the past decade, the Soviets' most pronounced improvements in strategic weaponry have been in the development of a MIRV ballistic missile capability and a significant improvement in the accuracy of their ICBMs. The former capability was made possible largely through the introduction of onboard digital computers and the latter through the improvement in the quality of the missile guidance systems and the procedures used to calibrate them. Technology acquisitions form the West contributed measurably to these improved capabilities.

The Soviets probably will continue to make their highest priority the acquisition of Western microelectronics and computer technology for in-flight guidance computers. This acquisition effort will be motivated by a desire to overcome reliability problems and also to provide the on-board processing capability required for the development of terminal homing guidance, a guidance option with the potential for extremely high accuracies.

The Soviets will also give top priority to acquiring information on the latest generation of US inertial components upon which the MX and the Trident guidance systems are based. Despite the past accuracy improvements of Soviets

ICBMs, these two US systems incorporate technologies beyond present Soviet capabilities. Moreover, their SLBM accuracies are significantly behind those of US systems. In addition to information on hardware, the Soviets are expected to seek calibration software algorithms which, as the guidance instruments themselves reach their practical performance limit, would allow for continued improvement in weapon system accuracy.

Western solid rocket propulsion technology will be a high-priority Soviet acquisition target in the 1980s. While the Soviets have vast experience with the liquid-propellant systems which represent the bulk of their ballistic missile force, they are shifting their emphasis to solid propulsion systems, which have practical advantages over liquid systems in a variety of applications. At the same time, the Soviets have had only limited success with the progress of their solid-propulsion program. They probably will pursue the acquisition of information on solid-propellant production procedures, and propellant grain design, motor case, and rocket nozzle technologies.

The Soviets' ABM R&D effort has continued since the 1960s. As a result, they have gained considerable expertise in the development of large fixed-site radars for early-warning, tracking, and engagement, and their interceptor technology has also improved substantially over the years. Areas remain, however, in which the Soviets will still seek and would benefit from Western ABM technology. These include signal processing for detection, discrimination, target assignment, and sensor technology, particularly in the long-wave infrared portion of the electromagnetic spectrum applicable towards improving their launch detection capability.

FUTURE SOVIET AIRCRAFT SYSTEM AND TECHNOLOGY NEEDS

Priority Soviet targets in this area will include Western materials technology, particularly composite materials to allow weight-efficient designs. The Soviets would also benefit from the acquisition of certain engine technologies, in particular those critical to the development of high-bypass turbofans. While, in general, the Soviets' avionics appear adequate, they have yet to demonstrate a capability to deploy reliable, accurate airborne inertial navigation systems for long-range navigation and weapons delivery. Thus, while long used in the West, these systems are still prime candidates for acquisition.

Very high priority probably will be given to the acquisition of computer-aided aircraft design technology, an area in which the Soviets are clearly impressed by US progress. In general, they also will continue to benefit from the acquisition of efficient aircraft production technology from the West.

While the Soviets have a strong indigenous air defense radar and missile technology, their general lag in microelectronics and microprocessing should direct them to attempt wherever possible in the West the acquisition of advanced signal-processing hardware and software.

FUTURE SOVIET NAVAL TECHNOLOGY NEEDS

The Soviets will continue to emphasize the acquisition of technologies applicable to improving their antisubmarine warfare capabilities, an area in which much Western technology is superior to theirs. Thus, a significant effort to acquire acoustic sensor technology can be expected, in particular that technology applicable to the development of large towed acoustic arrays that would assist the localization of Western submarines in open waters. They probably will also target the acquisition of signal-processing hardware and

software required to fully exploit the detection capabilities of these sensors.

Another critical problem area to which the Soviets will direct acquisition is that of submarine quieting. Here also the Soviets lag the West significantly. As a result, not only are their submarines more vulnerable to detection, but the self-generated noise reduces the effectiveness of their own acoustic sensors.

An area in which the Soviet have historically lagged the West is in precision submarine navigation -- in particular, in the development of submarine inertial navigation systems. The need for improvements here will become more pressing as the Soviets develop long-range cruise missiles for land attack which require precise knowledge of launch location.

Finally, the Soviets will continue to target technologies related to large aircraft carrier (for high-performance aircraft) design and construction to reduce the likelihood of poor design choices that would arise in what is for them an entirely new type of construction program.

FUTURE SOVIET TACTICAL TECHNOLOGY NEEDS

Much of the Soviet acquisition effort in this area is likely to be targeted against seeker and sensor technology for tactical missiles and precision-guided munitions. The Soviets will apply considerable effort in particular to acquiring advanced Western electro-optical technology. As in other weapons areas, the signal processing and microelectroncs technologies supporting tactical weapon systems will also be priority acquisition targets. Technical documentation on entire weapon systems, if obtained, will be used to develop countermeasures.

FUTURE SOVIET MICROELECTRONIC TECHNOLOGY NEEDS

The USSR is now at the stage of implementing its LSI (large-scale integration) technology to high-volume production. Despite the large acquisitions of Western technology and production equipment over the past ten years which have brought them to this level, additional acquisitions from the West are needed for the more sophisticated weapons projects of the future. Ever-increasing needs for higher precision Western equipment will extend at least through the 1980s. In addition, the Soviets will require considerable expansion of their microelectronic material base to support continued expansion of integrated-circuit production. In this regard, the USSR is seeking Western help to build two or three poly-silicon plants that will more than double current Soviet capacity. Also, with increasing advances in the technology, the USSR will be seeking additional Western assistance in key complementary technologies such as packaging and printed circuit board production.

The USSR is expected to focus its future acquisitions efforts on the emerging technologies related to very-high-speed integrated circuits (VHSIC) and very-large-scale integration (VLSI). It is important to note that, while VHSIC is thought of as a military development program, and VLSI as a civilian technology, there is little difference between the two as far as Soviet production needs are concerned. The same materials, production, and test equipment will be used to produce both. Furthermore, in both of these areas, the USSR has over the years developed effective means and methods for illegally acquiring Western advanced products.

FUTURE SOVIET COMPUTER TECHNOLOGY NEEDS

Prime Soviet collection efforts in computer technology through the 1980s are likely to include large-scale scientific computers such as the US-built

CRAY-1 Computer. Computers of that class offer significant improvements over Soviet models in weapons-systems design and simulation and in the processing of numerical data for many military applications. Other hardware targets will include: very dense random-access memory chips; high-capacity disk drives and packs; the so-called "superminicomputer" class of machines; and the latest in general purpose computer technology. All of the above targets offer opportunities for significant performance improvements and represent technologies of substantial Soviet lag.

In the area of computer software, the Soviets will continue to attempt to collect IBM programs and programs of other vendors written for IBM machines because of past Soviet decisions related to copying IBM computers. The large and growing number of IBM-compatible computers in the USSR means that collection activity in this area can be expected to increase. Because IBM plans to make some of their newest operating systems the bases of their future software, the Soviets are likely to make this a prime target for future exploitation. The compelling attraction of computer networks should spur great Soviet interest in acquiring network-control software and other programs related to networking.